Evolution of Cirrus and Deep Convection Property associated with West Pacific Typhoons

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Introduction

Tropical cyclones (TCs) are important weather phenomena that influence regional and global climate mainly through modulating hydrological cycle and energy transport. TCs reaching hurricane/typhoon categories have significant environmental and social impacts. Meteorological satellites prove to be power tools to study TCs from a global perspective.

The Advanced Himawari Imager (AHI) onboard Himawari 8 and 9 is a 16 channel imager and provides continuous observations over west Pacific TCs with both high spatial and temporal resolution.

Most studies of TCs from satellite observations use brightness temperatures. Utilizing AHI cloud properties retrieved from the Clouds from AVHRR Extended (CLAVR-x) processing system, this study aims at examining the evolution of cirrus and deep convective clouds (DCC) during typhoon lifecycles.

Clavr-x

- is a fast retrieval package capable of running large datasets for climate studies
- provides cloud retrieval algorithm for NOAA's operational use
- utilizes both solar and infrared bands and combines the retrieval of cloud mask, type, top properties and optical and microphysical parameters in one package.
- is able to run on most current satellite sensors onboard both geostationary and polar-orbiting satellites.

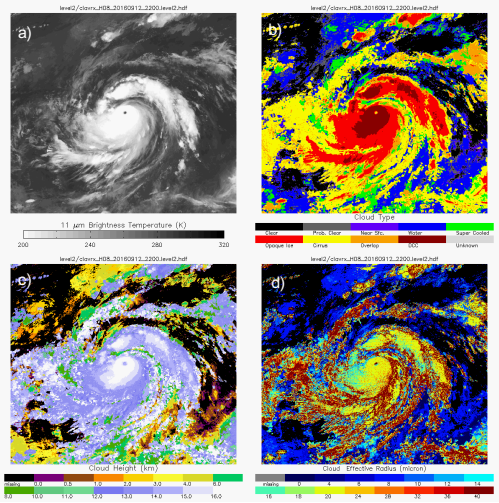

Figure 1. An illustration of (a) 11um brightness temperature (b) retrieved cloud type (c) cloud top height and (d) cirrus effective particle size at 2200UTC on September 12, 2016 for Meranti during Super Typhoon (category 5) stage.

Data and Methods

- Hourly AHI data processed through Clavr-x from September 10-14 for Super Typhoon Meranti, and from September 23-26 for Typhoon Megi.
- Maximum surface wind speed is from SSEC/CIMSS ADT.
- Study area is TC following with radius of around 1400km from the storm center
- Examine evolution of cirrus and DCC properties in the whole study area and in selected radii from the center, similar as Dunion et al. (2014)

Results

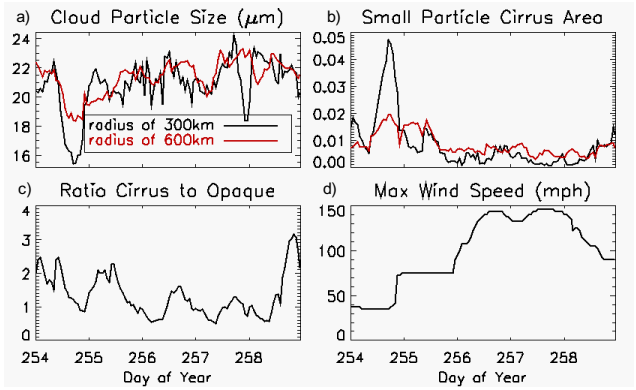

Figure 2. Time series of (a) mean cloud particle size (b) normalized cirrus area with particle size less than 15μm in a region with a distance of 300km and 600km from the TC storm center (c) ratio of cirrus to opaque clouds and (d) maximum sustained surface wind speed for Super Typhoon Meranti.

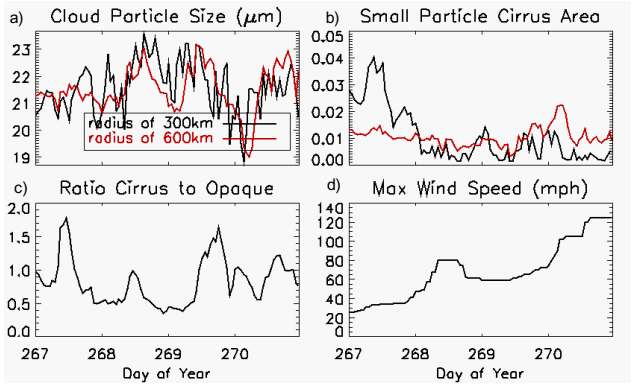

Figure 3. Similar as Fig. 2 but for Typhoon Megi.

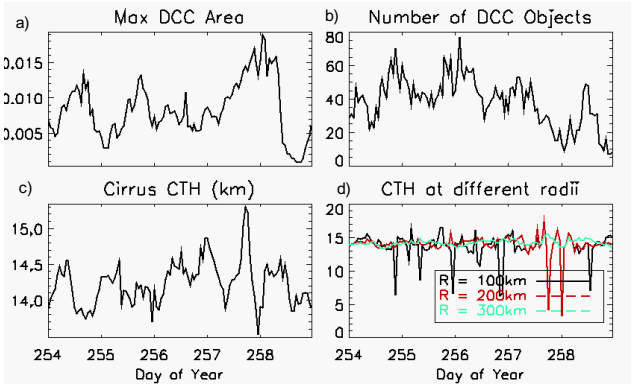

Figure 4. Time series of (a) maximum individual DCC area (b) number of separated DCC objects (c) mean cirrus CTH for the study area and (d) azimuthally averaged cirrus CTH at three radii from the TC center. Here DCC pixels based on cloud type are grouped into different regions, and the region with largest area is denoted as maximum DCC area and number of objects are counted. Normalization is applied to max DCC area.

Summary

- A large fraction of small particles are detected at early developing stage of TCs, which are likely low level small particles transported by strong updrafts when TCs are maturing.
- Particle sizes are larger and cirrus cloud tend to be suppressed in mature stage, whereas DCC areas are increased
- Nearly all cloud variables exhibit diurnal and shorter timescale variations
- Diurnal variations are not only controlled by the TC intensity but also distance from the TC center, particularly for CTH

Future Wok

- Extend the study from a climate perspective;
- Include the Atlantic basin as a study region with other geostationary satellite data, particularly the newly launched GOES-R

References

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